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(71) Applicant *(for all designated States except US)*: MYDATA AUTOMATION AB [SE/SE]; Adolfsbergsvägen 11, S–168 66 Bromma (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: HANSSON, Jens [SE/SE]; Edsviksvägen 79, S–182 38 Danderyd (SE). NILSSON, Kenth [SE/SE]; Trälhavsvägen 42, S–184 60 Åkersberga (SE).

(74) Agents: LINDÉN, Stefan et al.; Bergenstråhle & Lindvall AB, P.O. Box 17704, S–118 93 Stockholm (SE).

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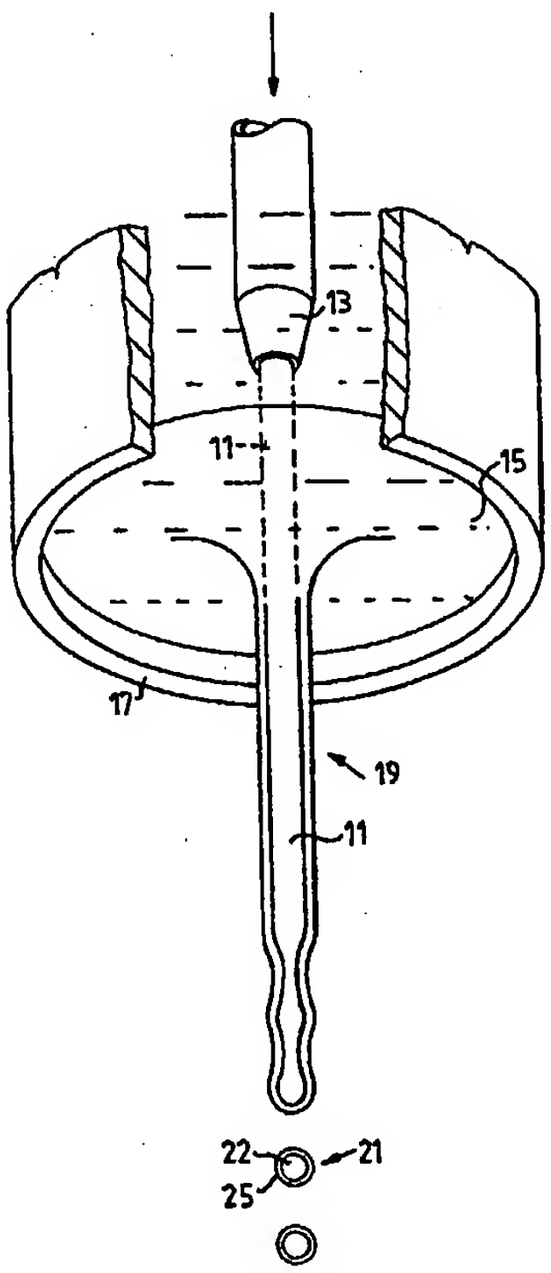
(54) Title: APPLYING DROPS OF A PRIMARY LIQUID TOGETHER WITH A SECONDARY LIQUID TO A SUBSTRATE

(57) Abstract

When applying solder paste to substrates, for example circuit boards, a jet comprising a fluxing agent (15) on top of a core of molten solder (11) is used. It is achieved by making a jet of molten solder (11) pass through a space filled with the fluxing agent. For suitable conditions the jet (19) is divided into drops (21), when it has passed out of the space filled with fluxing agent. Those drops, which hit the substrate, the consist of a core (22) of solidified solder surrounded by an enclosure (25) of fluxing agent. The applied solder paste thereby becomes completely fresh, which means that only an extremely small amount of oxide exists in the paste. Furthermore, in the corresponding way individual drops of solder can be ejected through the space filled with fluxing agent, which allows a very accurate dosing of the amount of solder paste, since the amount is determined by the number of solder balls and this number can be digitally controlled. This method can generally be used to apply a first liquid material having an enclosure of another liquid material, the first material advantageously being a material such as molten metal, which is significantly more heavy than the material of the enclosure.



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APPLYING DROPS OF A PRIMARY LIQUID TOGETHER WITH A SECONDARY LIQUID TO A SUBSTRATE

TECHNICAL FIELD

The present invention relates to a device for placing with a high velocity small volumes of a material in liquid shape on a substrate by ejecting drops of the material from a chamber through a nozzle. The material can comprise viscous media and dispersions and in particular be a viscous dispersion such a solder paste and various kinds of adhesives.

BACKGROUND

In a common method, when manufacturing electrical circuit boards by means of surface mounting electronic components on the boards, first a pattern of solder paste is applied to a circuit board by screen-printing or dispensing. Thereupon the components are placed in the sticky paste, which retains them at their positions during the remelting. The remelting can be made by the heating the assembly using e.g. heated air.

Solder paste mainly consists of solder balls and a fluxing agent. The solder paste can, in order to make it adapted to different purposes, be varied both as to the size of solder balls and the composition of the fluxing agent. One can thereby influence e.g. soldering properties, viscosity and durability.

The permanently continuing miniaturization of electronic components implies that the pattern of electric conductor paths on circuit boards becomes finer and finer, including more and more narrow conductor paths, and that the conductor paths are placed closer and closer to each other. Thus it becomes, using the known methods comprising screen-printing and dispensing, also more and more difficult to portion the intended quantities of solder paste at the correct positions on the small solder isles of the circuit board pattern.

A method, which one has started to study in order to manage the new, small solder isles, is "continuous liquid jet printing". Here the knowledge obtained from the "continuous ink-jet" method for conventional printers for computers is applied, using molten solder to replace the ink used in printers. Molten solder is driven through a capillary of e.g. glass by a pressure to form a solder jet. On its way from the nozzle to the substrate, i.e. the circuit board, the jet collapses into individual drops. The formation of drops is often, in order to increase the reproducibility of the process, supported by mechanical vibrations acting on the jet. The vibrations are generated by a piezoelectric crystal mounted on the capillary, the crystal being exposed to a suitable electric voltage. In the so called drop forming point selected solder drops are electrically charged in order to allow a deflection thereof in an electric field. This "continuous solder-jet" method is broadly described in the article "MPM's Metal Jet Technology - Solving the Materials Applications Tasks of the Future and Enabling Ongoing Miniaturisation", Electronics Manufacturing International, Reed Elsevier, Bryssel, Nov./Dec. 1996, p. 16, including

both applying mechanical vibrations to a solder jet and electrostatic deflection of formed drops.

In this method it may happen that drops solidify during their travel towards the substrate. What hits the substrate is thus either a jet of solid particles or drops having a high temperature, which solidify, when being cooled when they come in contact with the circuit board. In both cases it can be difficult to make the particles wet and attach to the circuit board and form the small isle of solder which is desired. In the case of solid particles hitting the board conventionally some form of sticky coating on the circuit board is required in order for the particles to be attached thereto. However, even if such a coating is used, the particles can not be attached on top each other, what is necessary in order to obtain the desired height of the soldering isle. In the case of molten drops they can possibly be fusioned to each other but it can be difficult to control the shape of the soldering isle and to avoid that spatters of solder are obtained, i.e. tiny drops of solder which are thrown out from the solder isle. Another disadvantage is that for the subsequent soldering of the components a fluxing additive to the solder is required. Using the above described method the solder must be added separately.

In U.S. patent 4,828,886 application of small amounts of molten solder from a nozzle is disclosed. After melting the solder it is propelled by means of a piezoelectrical transducer used as a pressure generator. An electrodynamic pump for dispensing molten solder is disclosed in U.S. patent 5,377,961, which is suitable for producing and applying very small individual drops. An electric current is applied with a reversible direction in a stream of solder and a force on the solder stream is obtained by interaction with a surrounding magnet. It is used for separating the small drops. In U.S. patent 5,560,543 is disclosed how uniformly-sized and predictably-shaped droplets having a can be generated from a liquid at a high temperature. A jet of the liquid is ejected by being electromagnetically driven from a nozzle, vibrations being produced in the liquid in its way towards the nozzle, so that drops are formed.

SUMMARY

It is an object of the invention to provide a method and a device for accurately controlled application of molten metal, e.g. solder, in the shape of a jet or drops to a substrate, such as a circuit board, by means of which the molten metal can be made to securely attach to the surface of the substrate.

It is another object of the invention to provide a method and a device, by means of which molten metal, e.g. solder and a secondary liquid, e.g. a fluxing agent, can simultaneously and with a high accuracy be applied to a substrate such as a circuit board.

By using a combined jet of fluxing agent/liquid solder, using the molten solder as a primary liquid and the fluxing agent/resin solution as a secondary fluid, the solder paste is generated or produced in the same instant in which it is needed. The drops which hit the substrate then consist of a core of molten solder surrounded by an enclosure of

fluxing agent/resin and thus constitute a form of soldering paste according to the discussion above.

Such a method allows a very accurate dosing of the amount of paste, since the amount is determined by the number of solder balls and this number can be digitally controlled. Another advantage is achieved by the fact that the soldering paste is completely fresh what means that only an extremely small amount of oxide exists in the paste. This is favourable from a soldering aspect, since the tendency of the paste to spatter in the remelting process increases strongly as dependent on an increased content of oxide in the paste. Solder spatters constitute a potential risk of short-circuits on circuit boards. In addition the low content of oxide in the paste results in a strongly increased wetting ability to metal surfaces. In order to even more reinforce this effect associated with a low content of oxide in the paste for example an anti-oxidation gas or generally a protective gas can be provided around the jet/drops of solder or solder balls surrounded by the fluxing agent directly after the generation and in its/their travel up to the substrate.

In the ink jet printer technology two basic concepts exist, "continuous ink-jet" and "drop on demand". Above the application of the "continuous ink-jet" principle for applying solder to substrates has already been discussed.

The "drop on demand" principle means, as the name indicates, that the drops are ejected one by one, one at a time, when is desired or required. When applying the method described directly hereinabove, these drops are made to consist of molten solder. The solder drops constitute as previously a "primary" liquid and they are made to pass through a secondary liquid comprising molten fluxing agent/resin. In the same way as above the primary drops then solidify to form balls and surround themselves with an enclosure of fluxing agent/resin. The drops can in and after creating them be surrounded by a protective gas in order to prevent for example oxidation of the material of the drops in their travel towards the substrate. The protective gas flow can for example be configured to be laminar or in some other suitable way, so that also a stabilizing effect on the creation of the flow of drops and on their path towards the substrate is obtained.

The advantage of the "drop on demand" principle is that only so much solder paste is produced which is required for coating the soldering isles of the circuit board, there is thus no "waste" paste. Furthermore, no deflection and thereby no electrostatic charging of the drops is required. However, ejector and substrate must be moved laterally in relation to each other in order to apply solder paste on desired positions on the substrate. However, such a displacement is also necessary for the "continuous ink-jet" method. The reason thereof is that in order to obtain a good hitting accuracy of the ejected drops one most frequently chooses to arrange an electrostatic charging of selected drops and to deflect precisely these drops which one wishes will not hit the substrate. In the "continuous ink-jet" case thus all drops, which one wishes will hit and be applied to the substrate, pass straightly out from the ejection nozzle. No other selective control using

the electrostatic deflection is used - the deflection works only analogously to an "on/off switch" or a cut-off valve, i.e. a switch or valve which either gives a complete closing or cutting-off effect or lets the full flow through.

Even if the method described above could also be applied to liquids, which can be mixed with other, it is better suited to liquids, which cannot be mixed with other, such as in the case indicated above including solder = primary liquid, fluxing agent/resin = secondary fluid. In the case of solder-fluxing agent/resin the conditions are particularly favourable owing to both the fact that the liquids cannot be mixed with each other and the fact that the density of the primary fluid is significantly higher than that of the secondary liquid. The density of the primary liquid is thus e.g at least four times the density of the secondary liquid, preferably at least seven times. The latter fact results in that when applying the secondary liquid to drops of the primary liquid only a small amount of kinetic energy is stolen from the primary liquid, i.e. the velocity of the primarily ejected drops is only moderately affected.

Generally thus, quantities of a material, which in the preferred case include a metal such as solder and another substance, are applied to a substrate. Such a quantity of a material can be obtained by first providing or producing a primary liquid, such as by melting a metal for producing the primary liquid. A jet of the primary liquid, in the special case thus a jet of the molten metal, is formed. Further, a secondary liquid is formed from the second substance, if is does not exist in a liquid shape, such as by heating to a state near being molten or by some similar method. The jet of primary liquid is made to pass though a first space, which contains the secondary liquid, so that the quantity of primary liquid obtains a surface coating of the secondary liquid. The secondary liquid of the coating may in some cases at this instant or later mix with the primary liquid. This does not happen in the preferred case including molten metal and the second substance containing as a main component or carrier some organic substance. The jet is made to pass from the first space through an opening thereof into a free state directed towards an intended position on the substrate. Various essential parameters, such as the properties of the primary liquid and the secondary liquid, in particular the surface tension of the liquids and their wetting ability in relation to each other, the velocity of the jet, the size of the opening and the distance from the opening to the substrate, are furthermore selected, so that the jet after passing out from the opening of the first space forms individual drops, before it reaches the substrate, i.e. during its travel towards the substrate.

Alternatively can instead of a jet a least one drop of the primary liquid be produced, which drop is given a high velocity. This drop is then like above made to pass through the first space, which contains secondary liquid, so that thereby the drop of primary liquid obtains a surface coating of secondary liquid. The drop is like the jet then made to pass out of the first space directed towards an intended position on the substrate. A series

of such individual drops of the primary liquid can be produced, which series like above then passes through the first space.

When forming a drop or a series of drops and ejection thereof with a velocity which can be high primary liquid may be provided in a second space provided with a nozzle. The nozzle can then have a suitable shape and/or be arranged in such a way, for example by being supplied with vibrations such as from a piezoelectrical device, that the primary liquid is divided into individual drops after passing through the nozzle. However, this method can only produce a series of drops. Alternatively, in order to also produce individual drops, different devices may be provided to subject the primary liquid in the second space to a rapid pressure change and/or a pressure blow and/or a rapid volume change or a sequence of such changes/blows, so that in some way an acceleration of at least some portion of the primary liquid in the second space is produced. For each such change/blow then a small quantity of primary liquid will be ejected, having the shape of a drop, through the nozzle, provided that the location of the nozzle is suitably selected considering the method by which the change/blow or acceleration is produced and/or considering the place where the change/blow is made. For example, such devices can comprise a suitably designed plunger, which is movable in the second space or forms a wall thereof, piezoelectrical means, devices for shock heating the primary liquid or a hammer, hitting on an exterior wall of the second space.

The primary liquid can in the preferred case have a density which is considerably higher than that of the secondary liquid, such as in the case including solder and fluxing agent. Further, in the standard case, these liquids cannot be mixed with other. The secondary liquid can generally comprise only or as a component substances for modifying the rheologic properties of the primary liquid, substances for preserving the primary liquid, substances having a chemically reducing effect on the primary liquid, antioxidation agents and surface active agents, for example adhesives for making drops of the primary liquid attach to the substrate.

A protective gas can be used to protect the ejected quantities of a material such as from oxidation and contamination. It is then suitably issued from an annular nozzle surrounding the ejection opening, so that the issued protective gas will surround the ejected quantities of a material at least partly during their travel towards the substrate. Such a flow of protective gas can also be designed, for example designed as a laminar flow, to produce a stabilizing effect on the production of drops from the amount of primary liquid together with secondary liquid and/or on the path of the quantities of a material or of the drops towards the substrate. Furthermore, electrostatic deflection can be used to deflect not desired drops.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be

realized and obtained by means of the methods, processes, instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

While the novel features of the invention are set forth with particularly in the appended claims, a complete understanding of the invention, both as to organization and content, and of the above and other features thereof may be gained from and the invention will be better appreciated from a consideration of the following detailed description of non-limiting embodiments presented hereinbelow with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view illustrating a principle of applying solder paste,

Fig. 2 is a sectional view of a device for applying solder paste, in which solder is ejected as a jet or a series of drops,

Fig. 3 is a section of a device for applying solder paste, in which solder is ejected as individual drops, and

Fig. 4 is a section similar to that of Fig. 2 but the device is here provided with electrostatic deflection.

DETAILED DESCRIPTION

In Fig. 1 a principle is illustrated, in a strongly magnified scale, of applying solder paste by means of a composite jet. A jet 11 of a primary liquid originating from some suitable source, not shown, is ejected from the opening of a nozzle 13 and passes thereupon through a secondary liquid 15, which is provided in an open space bounded by a cylindrical side wall 17 which is concentric with and surrounds the nozzle 13. The secondary liquid can be maintained in the open space owing to surface tension forces and possibly by a suitable design of the side wall 17, which may not have the cylindrical configuration shown in this figure but can be designed to be conically tapering having a small opening. The jet then surrounds itself by an enclosure of the secondary liquid 15 in order to form a composite jet 19. The combined jet 19 of primary fluid 11 plus secondary fluid 15 then disintegrates, for suitable parameters selected for the procedure, owing to surface tension, etc., into drops 21, which are constituted of a core 22 of primary liquid, enclosed by a shell 25 of secondary liquid.

In Fig. 2 the application of solder paste to a substrate or circuit board 27 located on a table 29 is shown, the table being movable in two perpendicular directions which are located in the plane of the table and one direction of which is indicated by the arrow at 31. A jet of primary liquid 11 consisting of e.g. molten solder is ejected from a nozzle 13, which is arranged at the lower end of a conduit 33, at the other end of which primary liquid 11 is supplied, see the arrow 35. For a suitable shape of the nozzle 13 the ejected jet can for example directly form drops in the secondary liquid 15. The secondary liquid consisting of e.g. a fluxing agent/resin solution arrives from some source, see the arrow 37, through a channel 39 perpendicular to the conduit 33 of the primary liquid and passes

then into a space 41 which is concentric with the conduit and is formed in an ejection body 43, to which the conduit 33 is also attached. The secondary liquid 15 is therefrom conducted to a space 45 surrounding the nozzle 13 of the primary liquid. This space 45 is also concentric with the conduit 33 and the nozzle 13 has lower edges 47 which are bent inwards, so that a nozzle for secondary liquid is formed. The drops or the liquid of primary liquid pass/passes through the secondary liquid 15 in the space 45 and then encloses themselves/encloses itself with an enclosure of secondary liquid. When the drops consisting of the primary liquid 11 plus the secondary liquid 15 are ejected from the nozzle of the secondary liquid formed by the edges 47, they will in a way similar to that described above will be constituted of a core a primary liquid, surrounded by a shell of secondary liquid. The drops can be surrounded by a protective gas, which from some gas source arrives through an annular nozzle 48 placed at the outlet of the space 45 next to the edges 47 at the exterior side of the ejection body 43, in order to prevent for example oxidation of the molten metal on its way down to the substrate 27. The gas flow can for a suitable design of the annular nozzle 48 be configured to be laminar, compare the arrows 48', or in some other way, so that in addition a stabilizing effect on the formation of the drop flow and on its travel towards the substrate is obtained.

The displacement of the table 29 in relation to the ejection body 43 can easily be achieved in known automatic mounting/coating machines for example by providing the table 29 to be movable in a first horizontal direction and the ejection body 43 to be movable in a second horizontal direction which it is perpendicular to the first one.

In Fig. 3 a cross-sectional view of an ejection mechanism for generating individual, ejected composite drops is illustrated. The primary liquid consisting e.g. of molten solder arrives through a pipe 49, which is partly closed at its lower end in order to form an opening or a nozzle 13 having a suitably configured, rather small outlet. The pipe 49 is arranged in an ejection block 53, which contains means for shooting a small drop through the nozzle. Such means can for example produce a small reduction of the volume of the interior volume of the pipe 49, in which the primary liquid is located. In the embodiment shown the pipe 49 is surrounded, within its portion inside the block 53, by an annular body 55 of a piezoelectrical material, which is connected to suitable electrical circuits, not shown, in order to produce a controlled reduction of the inner diameter of the annular body 55. The nozzle 13 mouths like in Fig. 2 in a space 45 containing secondary liquid. The secondary liquid consisting of e.g. a fluxing agent/resin solution arrives through a channel 57 perpendicular to the pipe 49 and therefrom passes through a channel to the lower space 45 which surrounds the nozzle 13 of the primary liquid. This space 45 is concentric with the pipe 49 and with the nozzle 13. An opening 59 of the lower space 45 is directed downwards and has a suitable shape for forming an exterior nozzle letting formed drops through.

When the ejection means 55 is activated, the volume of the pipe 49 is reduced and a

drop of secondary liquid is ejected with a high velocity through the nozzle 13. The drop passes through the secondary liquid in the lower space 45 and then surrounds itself with an enclosure of secondary liquid. The composite drop thus formed then moves out through the exterior nozzle 59 in order to be applied to the intended position.

To apply drops in the way described above can be combined with electrostatic deflection as in the method "continuous jet" as described above. A device having such a deflection is schematically shown in Fig. 4. It has an upper electrically conducting, cylindric ring or a cylindrical short pipe 61, which surrounds and is concentric with the upper portion of the path of the generated drops. Between the ring 61 and the house 45 can at selected occasions an electric high voltage be applied, which is generated by an electrical control unit 63, which is thus through suitable electrical conductors connected both to the ring 61 and to the house 43. The voltage can for example be applied, so that the house obtains a negative potential or ground potential, whereas the ring 61 has a positive potential. When the voltage is applied, a drop, which is separated from the jet which comes out of the house 43, becomes electrostatically charged, provided that the liquid in the drops has some electric conductivity, and for the polarity of the high voltage mentioned as an example such a drop becomes negatively charged. Below the ring 61 electrically conducting plates 65 are provided which are parallel to each other and also parallel to the axis of the ring 61 and which with their large surfaces facing each other surround a lower portion of the path of the ejected drops. The plates 65 are also electrically connected to the control unit 63, so that a high electrical voltage is generally permanently applied between the plates. This voltage deflects only those ejected drops which are electrically charged, so that they are conducted to some space, not shown, which works as a "drain" and which can receive a considerable amount of drops. The ejected drops which have no electrical charge instead travel straight ahead towards the substrate and hit it and are applied there.

While specific embodiments of the invention have been illustrated and described herein, it is realized that numerous additional advantages, modifications and changes will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative devices and illustrated examples shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents. It is therefore to be understood that the appended claims are intended to cover all such modifications and changes as fall within a true spirit and scope of the invention.

CLAIMS

1. A method of applying quantities of a material comprising two liquids, a primary liquid and a secondary liquid, to a substrate, **characterized** in that a quantity of primary liquid is made to pass through a first space, which contains secondary liquid, so that the quantity of primary liquid obtains a surface coating of secondary liquid, and out of the first space directed towards an intended position on the substrate.

2. A method according to claim 1, **characterized** in that the quantity of primary liquid is a jet, a series of drops or a single drop.

3. A method according to any of claims 1 - 2, **characterized** in that the primary liquid has a density which is significantly higher than the density of the secondary liquid.

4. A method according to any of claims 1 - 3, **characterized** in that the primary liquid is molten metal, in particular solder, and the secondary liquid comprises an organic or anorganic fluid, in particular a fluxing agent or resin in a semimolten or molten form, selected in order to improve the applying of the quantity of primary liquid to the substrate and/or the use of the quantity of primary liquid.

5. A method according to any of claims 1 - 4, **characterized** in that the quantity of primary liquid is a jet, which passes out of the first space through an opening designed to have a suitable size, so that the jet after the exit of the opening is divided into individual drops.

6. A method according to claim 5, **characterized** in that the primary liquid and the secondary liquid are so selected, that the individual drops comprise an interior part of primary liquid and an exterior layer of secondary liquid.

7. A method according to any of claims 1 - 4, **characterized** by the additional steps of

melting a metal for forming the primary liquid,

forming a jet of the molten metal,

forming the secondary liquid from a substance different from the metal,

making the jet pass through the first space,

making the jet pass from the first space through an opening thereof into a free state directed towards the intended position, the primary liquid and the secondary liquid, the velocity of the jet, the size of the opening and the distance from the opening to the substrate are so selected, that the jet after passing out of the opening of the first space forms individual drops before reaching the substrate.

8. A method according to any of claims 1 - 4, **characterized** in that the quantity of primary liquid is a series of drops, which are formed by making the primary liquid pass out of a second space into the first space through a suitably designed and/or arranged nozzle.

9. A method according to any of claims 1 - 4, **characterized** in that the quantity of primary liquid is a single or individual drop, which is formed by making primary liquid

pass through or stay in a second space, which is provided with a nozzle, and by subjecting the primary liquid in the second space to a rapid pressure change and/or a pressure blow and/or a rapid volume change, whereby a small quantity of primary liquid having the shape of a drop is ejected through the nozzle.

10. A method according to any of claims 1 - 9, **characterized** in that a flow of protective gas is issued in order to surround the quantity of primary liquid together with secondary liquid, when this quantity passes out of the first space directed towards an intended position on the substrate, so that the protective gas encloses the quantity at least partly during its travel towards the substrate.

11. A method according to claim 10, **characterized** in that the flow of protective gas is issued in such a way, in particular as a laminar flow, that a stabilizing effect on the forming of drops of the quantity of primary liquid together with secondary liquid and/or the on the travel of quantity and the drops towards the substrate is obtained.

12. A method according to any of claims 1 - 11, **characterized** in that after the quantity of primary liquid together with secondary liquid has passed out of the first space directed towards an intended position on the substrate, the quantity is electrostatically charged and the quantity of primary liquid together with secondary liquid is subjected to an electrostatic field for control of the path of the quantity.

13. A device for applying quantities of a material comprising two different liquids, a primary liquid and a secondary liquid, to a substrate, **characterized by**

means for producing a quantity of primary liquid and for ejecting is with a velocity,

a first space, which contains secondary liquid and is so located, that the quantity of primary liquid passes therethrough and then obtains a surface coating of secondary liquid, and

an opening out of the first space located, so that the quantity of a material passes therefrom directed towards an intended position on the substrate.

14. A device according to claim 13, **characterized** in that the means for producing a quantity of primary liquid and for ejecting it with a velocity are arranged to generate a jet of primary liquid or to generate a series of drops or an individual drop of primary liquid.

15. A device according to any of claims 13 - 14, **characterized** in that the means for producing a quantity of primary liquid and for ejecting it with a velocity are arranged to generate a jet and that the opening out of the first space is designed to have a suitable size, so that the jet after exiting through the opening during its travel towards the substrate is divided into individual drops.

16. A device according to any of claims 13 - 14, **characterized** in that the means for producing a quantity of primary liquid and for ejecting it with a velocity are arranged to generate a series of drops and that the device further comprises

a second space, through which primary liquid passes or in which primary liquid

stays and which comprises a nozzle mouthing in the first space, and

means for making primary liquid pass out of the nozzle,

the nozzle having such a shape and/or being arranged in such a way, that the primary liquid is divided into individual drops after passing through the nozzle.

17. A device according to any of claims 13 - 14, **characterized in that** the means for producing a quantity of primary liquid and for ejecting it with a velocity are arranged to generate a drop and that these means further comprise

a second space, in which primary liquid stays and which is provided with a nozzle, and

means for subjecting primary liquid in the second space to a rapid pressure change and/or a pressure blow and/or a rapid volume change, whereby a small quantity of primary liquid in the shape of a drop is ejected through the nozzle.

18. A device according to any of claims 13 - 17, **characterized by** a nozzle connected to source of a protective gas for issuing a flow of protective gas, so that the flow surrounds the quantity of a material, when it passes out of the opening towards the intended position on the substrate and so that the protective gas encloses the quantity at least partly during its further travel towards the substrate.

19. A device according to claim 18, **characterized in that** the nozzle for the protective gas is designed, so that the protective gas is issued therefrom in such a way, in particular as a laminar flow, that a stabilizing effect on generating drops from the quantity of primary liquid together with secondary liquid and/or on the travel of the quantity during its further travel towards the substrate is obtained.

20. A device according to any of claims 13 - 19, **characterized by**

an electrostatic charging device located at the path, which the quantity of primary liquid together with secondary liquid has, after having passed out of the opening, which charging device is connected to electrical high voltage for charging the quantity of primary liquid having a surface coating of secondary liquid,

deflection plates located around the path, which the quantity of primary liquid having a surface coating of secondary liquid has, after having passed the electrostatic charging device, which plates are connected to an electrical high voltage for electrostatic deflection of the quantity of primary liquid together with secondary liquid.

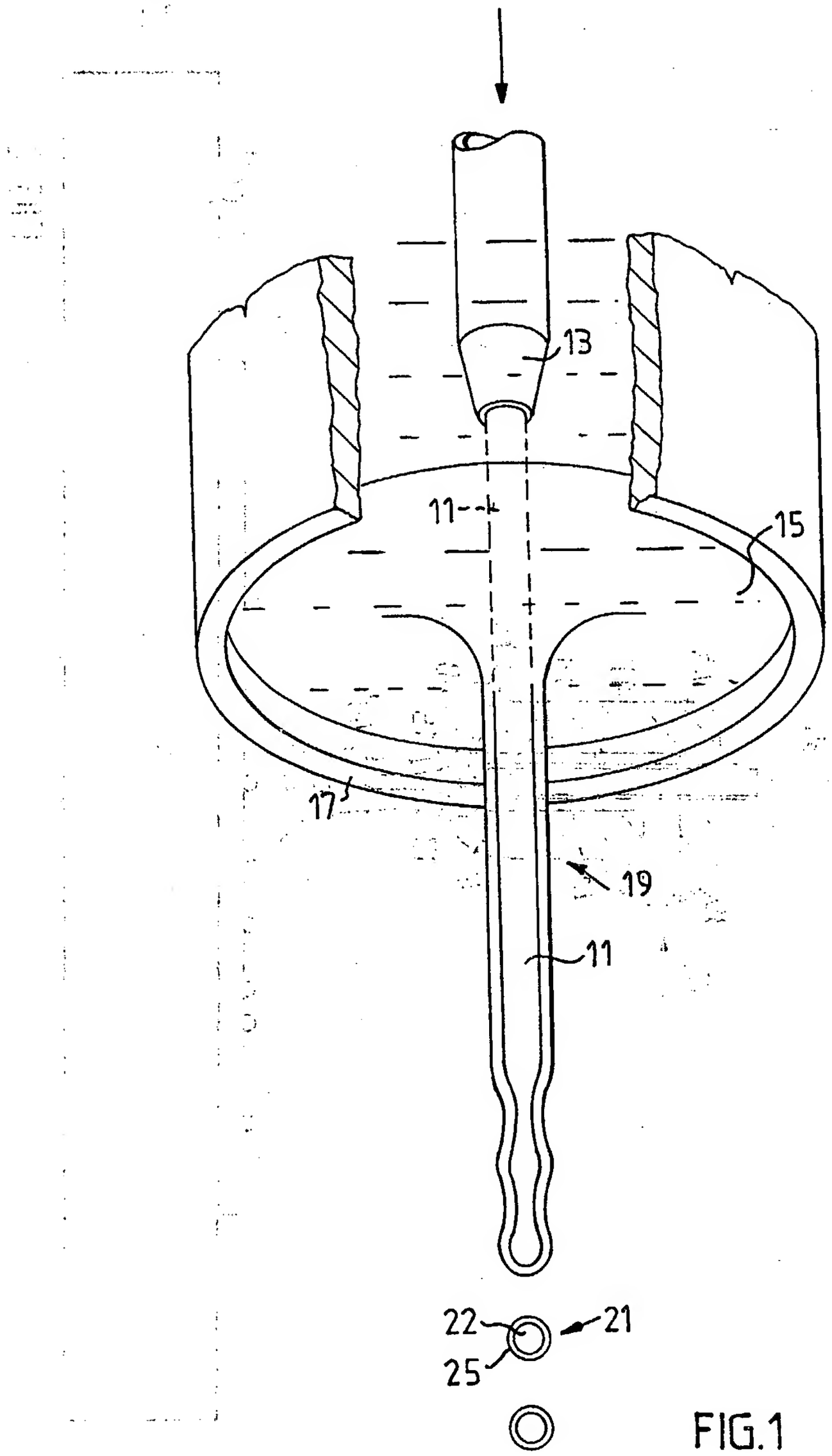

FIG.1

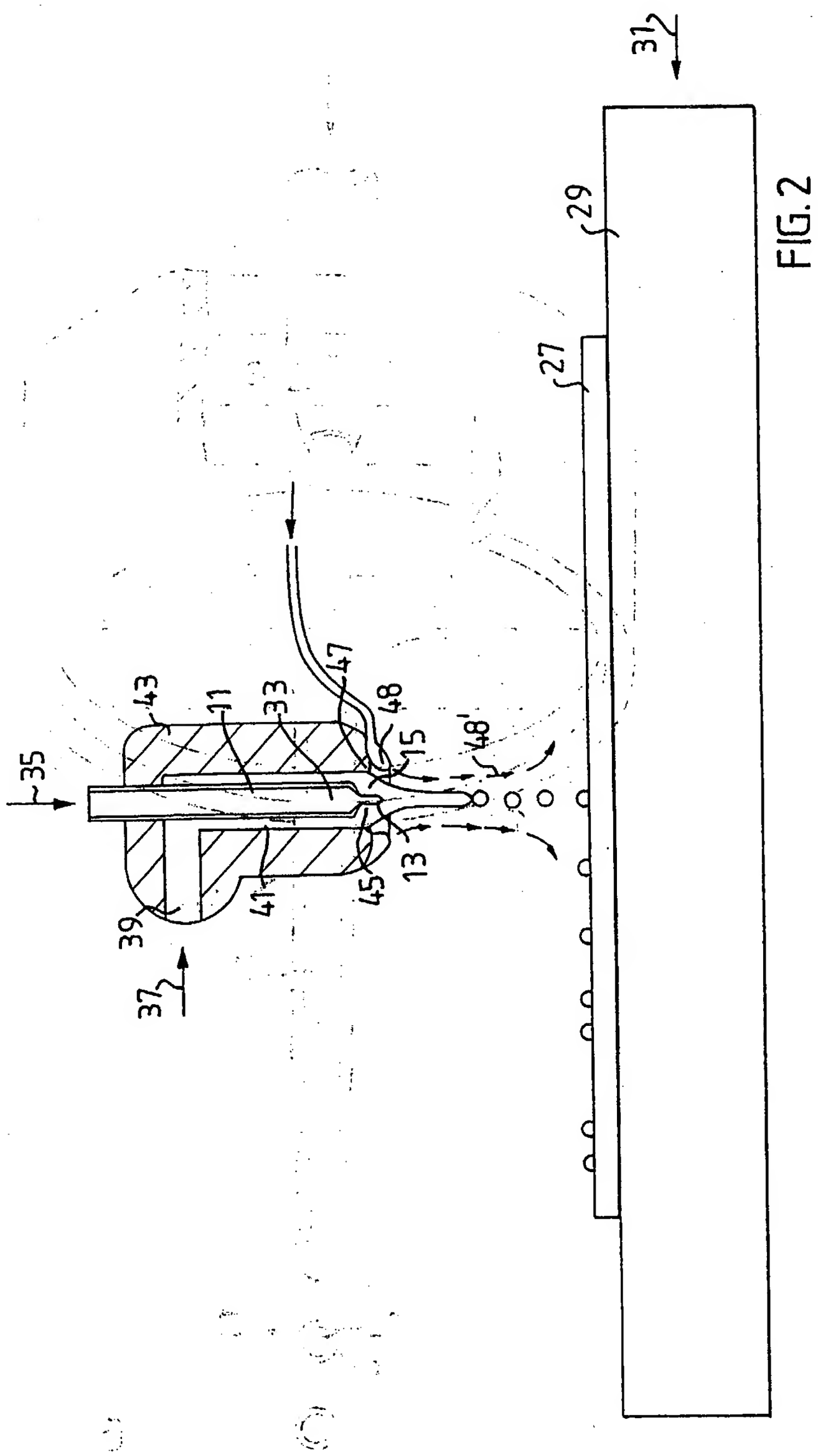

FIG.2

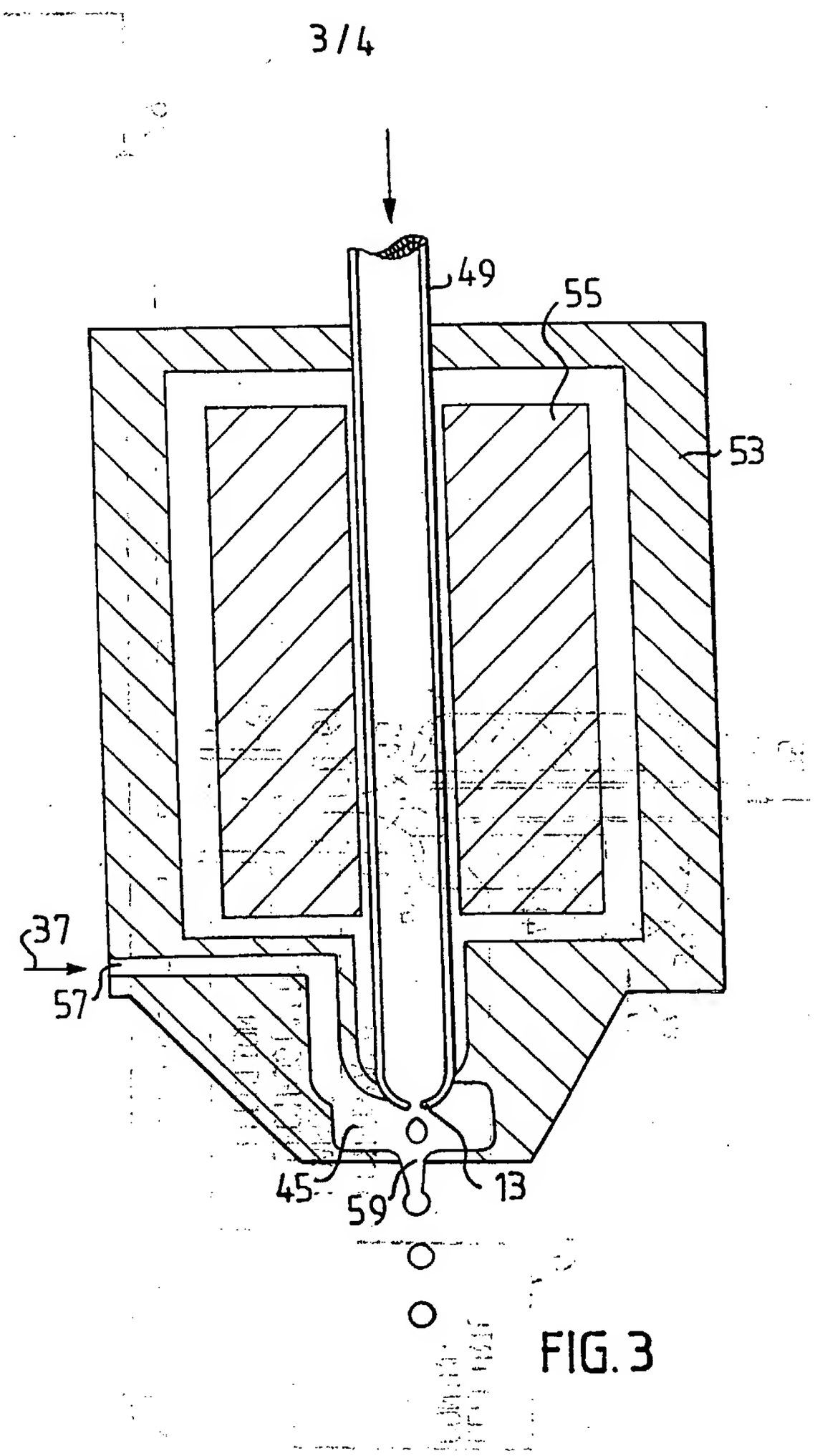

FIG. 3

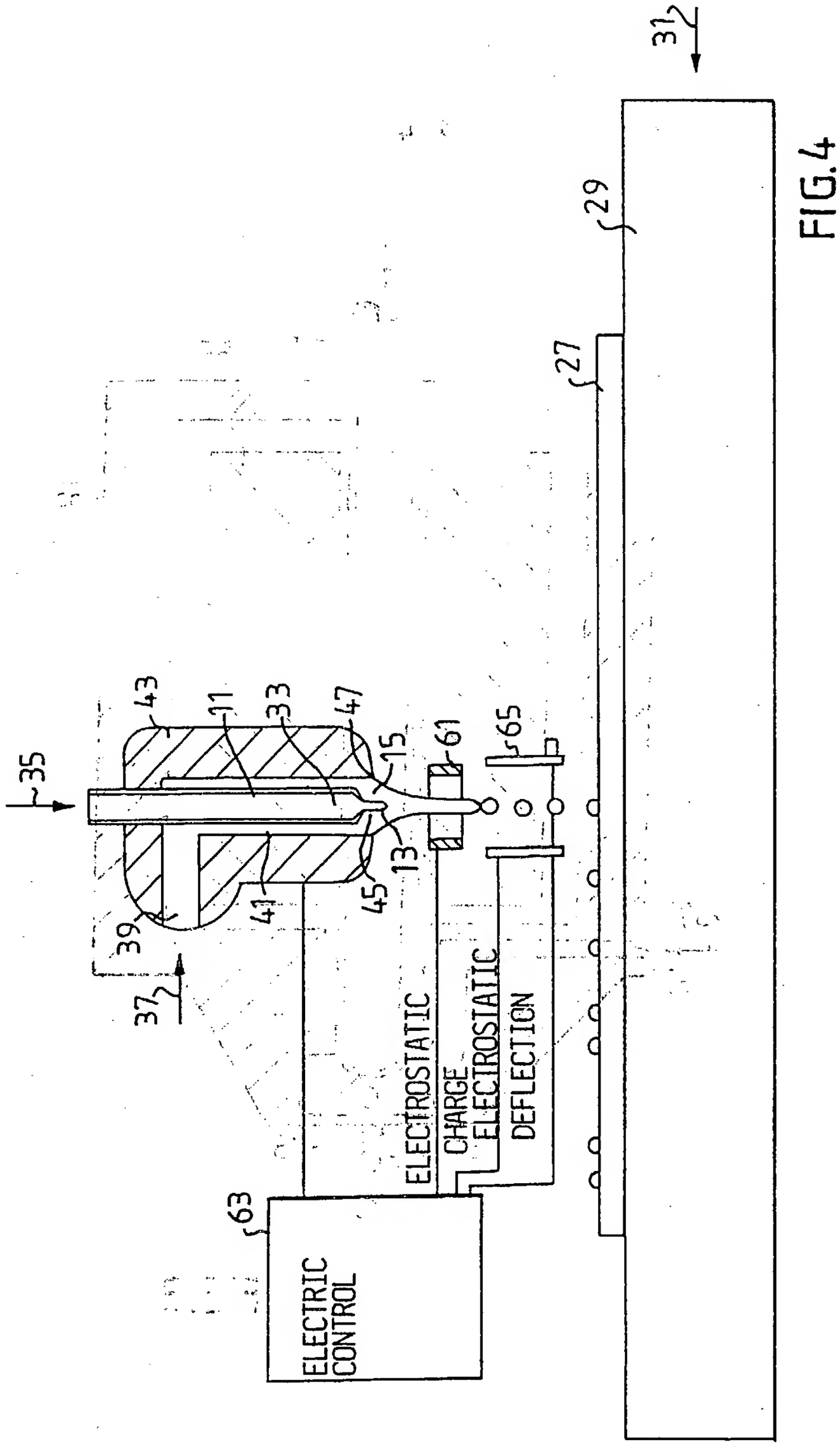

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01002

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B23K 3/06, B05D 1/34
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B23K, B05C, B05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 8905567 A1 (HAMMERSHØJ, RENE), 15 June 1989 (15.06.89), page 9, line 21 - page 10, line 15, figures 1-13, abstract, claims --	1-20
X	US 4196437 A (CARL H. HERTZ), 1 April 1980 (01.04.80), figures 1-17, abstract, claims --	1-6,8,9, 12-17,20
A	US 5560543 A (CHARLES V. SMITH ET AL), 1 October 1996 (01.10.96), abstract --	1,13
A	US 4828886 A (HARTMANN HIEBER), 9 May 1989 (09.05.89), abstract -- --------	1,13

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 Sept 1998	25 -09- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ulf Nyström Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/07/98

International application No.
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